Older Adults' Use of Retrieval Strategies in Everyday Life

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Frank, D. J., Jordano, M., Browne, K. P., & Touron, D. R. (2016). Older adults' use of retrieval strategies in everyday life. *Gerontology*, *62*(6), 624-635.

This is the peer-reviewed but unedited manuscript version of the following article: Frank, D. J., Jordano, M., Browne, K. P., & Touron, D. R. (2016). Older adults' use of retrieval strategies in everyday life. *Gerontology, 62*(6), 624-635. The final, published version is available at http://www.karger.com/?doi=10.1159/000446277

Abstract:

Background: Despite declines in cognitive abilities, older adults often perform comparable to younger adults in everyday tasks [J Am Geriatr Soc 1999;47:172-183]. Older adults may compensate for cognitive declines by using more efficient strategies. People often improve their efficiency by switching from an algorithmic strategy where information is computed or looked-up, to a strategy where the information is retrieved directly from memory [J Exp Psychol Gen 1988;117:258-275]. However, older adults are reluctant to shift from algorithmic strategies to retrieval strategies in the laboratory, and this reluctance to use retrieval is driven by both bottom-up (slower learning) and top-down influences (memory confidence, motivation to be quick/accurate) [Psychol Aging 2004;19:452-466; Mem Cognit 2004;32:298-310]. ***Objective:*** We investigated whether bottom-up and top-down factors influence younger and older adults' decisions to use retrieval-based or algorithmic strategies in everyday life. ***Methods:*** In two studies, participants completed a daily diary for 5 (study 1) or 7 (study 2) days. Participants were asked if and how they completed daily activities within several everyday task domains. They also indicated for how long and how often they completed the specific activity (bottom-up factors), as well as how confident they were in using their memory and how motivated they were to perform the specific activity quickly and accurately (top-down influences). ***Results:*** Both studies provided evidence for bottom-up and top-down influences. Additionally, study 2 found that top-down factors (memory confidence and motivation to be quick) were more important for older compared to younger adults. ***Conclusion:*** These results indicate that strategy choices influence older adults' cognitive efficiency in everyday as well as laboratory learning.

Keywords: Strategies | Automaticity | Aging | Skill acquisition | Experience sampling

Article:

Older adults (OAs) often perform worse in laboratory tasks relative to younger adults (YAs) [1,2,3]. Despite these declines, most OAs function well in daily life, and age differences on everyday tasks are often reduced or absent [1,2,4,5,6,7,8]. For example, OAs struggle with laboratory prospective memory tasks [1], but are more likely than middle-aged adults to remember to take medications in everyday life [2]. These *naturalistic studies* measure learning and/or memory in everyday settings to maximize ecological validity (sacrificing experimental control) [9]. In addition to reduced age differences, performance in naturalistic studies does not always correlate with standardized measures of cognitive abilities [[4,6,7,9,] but see [10]]. By contrast, *simulation studies* replace standard laboratory stimuli with more ecologically valid stimuli to improve validity without sacrificing (as much) experimental control [9]. Simulation studies produce a mix of age decrements [5,8,11] and age equivalence [12,13], but again do not always correlate with standardized measures of cognition [[5], [8], but see [10]]. Given these differences, in particular OAs' tendency to perform better in naturalistic studies, it is important to investigate age-related changes both inside and outside the laboratory. In two naturalistic studies, we use a daily diary approach to investigate OAs everyday use of retrieval strategies - an area that has yet to be studied outside the laboratory.

RETRIEVAL USE

On many tasks, people can improve their efficiency by shifting from algorithmic processes, such as looking up or computing solutions, to retrieving solutions directly from memory [14,15,16,17]. For example, with practice, people switch from using a counting algorithm for multiplication problems to retrieving the answers directly from memory [16]. This not only allows for faster performance, but retrieval involves fewer cognitive resources than computing [14,18]. Thus, OAs might minimize their reliance on declining cognitive abilities if they rely more heavily on retrieval-based strategies when possible. Yet, this is precisely the opposite of what OAs demonstrate on laboratory tasks; OAs continue to use cognitively demanding algorithmic strategies (like looking up and computing answers) for much longer than do YAs [19,20,21]. For example, the noun-pair look-up task asks participants whether two words are paired together in a table. Initially participants must look-up the answers in the table, but with practice they memorize the word pairs and can respond without looking up [20,21,22]. OAs continue to look up long after YAs have switched to retrieving the answers from memory. OAs' delayed shift to retrieval results from both bottom-up and top-down influences [19,20,21]. We next describe these two categories and the literature on OAs' retrieval reluctance in the laboratory. We then discuss important differences between everyday and laboratory tasks and present two studies using a daily diary method to assess age differences in everyday retrieval use.

BOTTOM-UP AND TOP-DOWN INFLUENCES

Bottom-up influences are *stimulus-driven* influences. In the context of shifting to retrieval, we consider bottom-up influences to include how many times and how often one has seen the information. The more information is processed, the easier it can be retrieved from memory [15,17]. By contrast, top-down influences originate *within* the person. In this study, we examine top-down influences as memory confidence, beliefs, motivations, and biases [20,22,23,24,25,26]. OAs take longer to shift to retrieval, in part, because they require more repetitions to learn the information (bottom-up influences) [19,27], and in part because they choose not to retrieve the information even after it is learned [20,22,23]. For example, during the noun-pair look-up task, Touron et al. [20,22,23] allowed participants to either look up or retrieve an answer on some (standard) trials, but removed the look-up table on other (test) trials, requiring participants to attempt retrieval. Even after demonstrating a high level of accuracy on test trials, OAs, unlike YAs, continued using the look-up table on standard trials [20,22,23]. OAs' retrieval reluctance is related to: low memory confidence [20,24], bias favoring performance accuracy over speed [25,26], poor response time monitoring [23], and a general tendency to rely on external supports [22,28,29].

EVERYDAY RETRIEVAL USE

Everyday life deviates from laboratory settings in important ways. Laboratory tasks present hundreds of repeated trials in just a few hours; by contrast, learning everyday tasks often occurs over months or years. Additionally, OAs may have learned the requisite information for everyday tasks at a younger age and developed a habit of using memory for the task before they had concerns about their learning. OAs report high regularity in their daily lives, with similar activities completed on most days [30,31]. As a result, it is likely that everyday tasks fall within domains where OAs have expertise and potentially greater confidence. By contrast, laboratory studies use novel and unrelated stimuli in relatively unfamiliar environments. These methods optimize experimental control but deviate substantially from everyday learning situations. Lastly, OAs' speed-accuracy trade-off may be a product of the laboratory environment. In everyday life, OAs may be less concerned with accuracy if no one will know if they fail and the consequences of failure are minimal.

OAs' reliance on retrieval strategies in everyday life has not been studied, so it is unknown whether the top-down mechanisms that influence retrieval decisions in laboratory studies also influence everyday retrieval decisions. To address this gap in the literature, we conducted two studies using a daily diary approach to examine OAs' and YAs' retrieval decisions in everyday life. Each day participants indicated which everyday tasks (listed in table 1) they completed. For each task completed, they answered a series of questions regarding the specific activity they performed (e.g., the particular route they drove). Participants answered questions about the strategy they used to complete the activity, and their experience, motivation, and confidence. Study 2 used a somewhat larger sample size and refined methodology.

STUDY 1

Method

Participants

Pilot data suggested that OAs would perform more survey tasks per day compared to YAs. For this reason we used an unbalanced design with 15 OAs (ages 60-78) and 23 YAs (ages 18-21); an additional 5 YAs participated but were excluded from analysis because of incomplete surveys and noncompliance. YAs were undergraduates participating for course credit. OAs were recruited from the local community and paid USD 50 via gift cards. No participant reported a history of stroke or dementia. Participant characteristics can be found in table 2.

Table 1. Everyday tasks included in the daily diary survey

Tasks	Total responses (participants responding)	
	YAs	OAs
Study 1		
Preparing a dish from scratch*	8 (5)	26 (13)
Preparing a 'boxed' meal (e.g., making pancakes from a box, reheating a frozen pizza)	13 (8)	23 (12)
Mailing things (e.g., USPS, FedEx, UPS, etc.)*	1 (1)	6 (5)
Performing mathematical calculations (e.g., to leave a tip, balance checkbook, etc.)*	25 (11)	33 (11)
Entering a Web address	60 (19)	13 (9)
Entering an e-mail address	5 (4)	13 (9)
Making a phone call*	44 (14)	29 (11)
Checking a voicemail or answering machine*	12 (6)	38 (12)
Navigating to a TV channel	38 (16)	48 (13)
Driving	37 (13)	48 (14)
Shopping (for something in particular such as groceries, clothes, etc.)*	11 (8)	29 (14)
Locating items you are shopping for	10 (8)	26 (14)
Study 2		
Preparing a dish from scratch	6 (5)	51 (16)
Preparing a 'boxed' meal (e.g. making pancakes from a box, reheating a frozen pizza)	29 (20)	21 (9)
Preparing a beverage requiring more than one step (e.g., making coffee or tea)	35 (18)	109 (21)
Purchasing a meal or drink for someone else	15 (14)	16 (10)
Providing an address for any purpose (mailing, paper work, entering into GPS)	13 (13)	26 (12)
Checking a voicemail or answering machine	13 (14)	87 (17)
Navigating to a TV channel	91 (27)	187 (22)
Driving	136 (34)	206 (23)
Navigating a bus schedule*	21 (7)	0 (0)
Walking or biking (as a form of transportation)*	198 (38)	2 (2)
Locating items you are shopping for	24 (20)	77 (21)
Entering a password*	163 (38)	115 (17)
Entering a pin number (any numerical password, e.g., 2774)*	36 (16)	24 (11)

Tasks that did not yield adequate data to be entered into the logistic regression analyses are indicated with an asterisk. The right hand columns indicate the total number of times YAs and OAs in our dataset indicated performing an activity that fit the relevant task domain. The number in parentheses indicates the number of different participants who endorsed a given response at least once.

Table 2. Participant demographics

Demographics	Study 1						Study 2					
	young		old		age difference		young		old		age difference	
	mean	SD	mean	SD	p	d	mean	SD	mean	SD	p	d
Age, years	18.26	0.69	70.13	5.69			19.03	1.26	69.13	4.28		
Education, years	12.26	0.69	15.67	2.53	<0.001	1.84	12.89	1.39	16.30	1.96	<0.001	2.01
Processing speed	40.61	7.16	24.33	5.55	<0.001	2.54	37.79	7.45	27.74	6.66	<0.001	1.42
Vocabulary	15.13	3.22	23.67	6.59	<0.001	1.65	14.89	3.05	24.74	7.19	<0.001	1.78
Medications	0.70	0.82	2.07	1.58	<0.001	1.09	0.84	0.96	2.78	2.00	<0.001	1.24

Processing speed = Number correct on the Pattern Comparison Test [30]; vocabulary = % correct on the advanced vocabulary test [29]; medications = number of daily medications.

Materials

To create the pen-and-paper daily diary survey, we first devised a list of everyday tasks which could be completed using either retrieval or nonretrieval strategies. We included tasks where the retrievable information was likely to be consistent across occasions (e.g., a recipe does not change each time you prepare it) and generally avoided tasks where the retrievable information varies across occasions (e.g., looking-up or retrieving the current weather forecast). We also avoided tasks like ‘remembering names' where algorithms such as ‘asking the person's name' might have social consequences. We eliminated tasks that are unlikely to be performed on a regular basis, unlikely to be done using the same material more than once, or where estimating how often one has done the task might be difficult (e.g., answering trivia questions, remembering vs. looking up birthdates). Extensive verbal feedback on a small sample pilot study was used to refine the survey.

Each page of the survey listed 1 of the 12 tasks from table 1. If a participant performed an activity that fit the task domain, they were next asked how often they perform that specific activity in terms of times per day, month, or year, depending on which interval was easiest to estimate. They next estimated how many years (using decimals when appropriate) it had been since they first completed that particular activity.

The critical dependent variable was whether the activity was performed using a retrieval or nonretrieval strategy. Participants selected which strategy they used from a list of possible strategies, or indicated ‘other.' In the example in table 3, we coded, ‘I drove there without using directions because I retrieved them from memory', as a (pure) retrieval strategy. All other responses were coded as nonretrieval.[1]

Table 3. Strategy question example for daily diary survey

How did you retrieve directions to your destination?	
1	I looked up directions, wrote them down, and used them to drive to my destination
2	I looked up the directions, committed them to memory, and drove to my destination
3	I drove there without using directions because I retrieved them from memory
4	I used a map while driving
5	I used a GPS while driving
6	I had a passenger tell me where to go
7	Other

Option 3 was coded as retrieval. All other options were coded as nonretrieval.

[1] For both studies 1 and 2 we also analyzed the data using a more liberal coding where partial retrieval-based strategies (e.g., I looked up some things and retrieved others from memory) were coded as retrieval and again as half retrieval use. These analyses produced the same patterns of significance as those using the more stringent definition of retrieval use reported here.

The survey next asked participants, on a 5-point Likert scale (5 being greatest), how motivated they were to perform the task quickly, how motivated they were to perform the task accurately, how much their completion of the task *involved retrieving information from memory*, how much their completion of the task involved *holding/juggling information in memory*, and how *confident* they were in their ability to retrieve information from memory for the task. This procedure was repeated for each task domain. If a participant completed more than one activity that fit a task domain, they were asked to select one representative example and answer the questions based on that example.

Procedures

Participants first completed a series of demographic, cognitive, and metacognitive measures at an on-campus laboratory (see table 2 for demographic measures; for all online suppl. material, see www.karger.com/doi/10.1159/000446277).[2] Participants were next given detailed instructions on how to complete the daily diary survey, and any remaining questions about the survey were answered. Participants were asked to complete the daily diary (on paper) approximately 1 h before going to bed for the following 5 days. Participants then returned to the lab for debriefing and a follow-up questionnaire asking whether they had missed any days of the survey, and what they thought the purpose of the survey was. Lastly, we asked them to indicate how completing the survey influenced their behavior throughout the experiment. They had the option to endorse any combination of reactivity responses listed at the bottom of table 4. We also allowed participants to report any other reactions they had; no participant utilized this response option.

Results

Few YAs endorsed cooking from scratch or having checked voicemail, and always used retrieval (table 1 shows the number of participants endorsing each item and the total number of responses per item). Likewise, few participants endorsed mailing anything. These tasks did not provide adequate variance for an appropriate statistical analysis. We also removed tasks regarding mental math computations and remembering what to buy at a store. Mental math may tap working memory in addition to retrieval of information from long-term memory. Remembering what to buy at the store was deemed qualitatively different from the other survey tasks because the information to be retrieved changes at each instance. Lastly, we removed the making phone calls task because many YAs gave extremely high rates of phone usage, and/or provided nonnumeric responses (e.g., constantly, infinity, all day). We suspect that this phone usage included frequent back-and-forth text messaging, which typically does not require that the phone number be entered - and thus would not require a retrieval decision. After exclusion, 6 tasks remained, leaving 184 YA responses and 194 OA responses for analysis. OAs completed more activities

[2] We did not find consistent relationships between metacognitive questionnaire responses and retrieval use on the daily diary across the two studies. The relationships were difficult to interpret and appeared sporadic. Specifically, only the Metacognitive Compensation Questionnaire (MCQ) subscales were significant predictors of retrieval use and only in study 2. Participants endorsing more internal strategies (e.g., using elaborate encoding strategies) were paradoxically less likely to rely on retrieval in everyday life. YAs who endorsed exerting more effort to improve performance (MCQ effort scale) and those having noticed more changes in memory (MCQ change scale) were paradoxically more likely to use retrieval. YAs who endorsed taking more time on tasks as a means of improving performance (MCQ time scale) were less likely to use retrieval, whereas OAs doing so were more likely to use retrieval. Means for these measures can be found in the online supplemental materials.

per day (mean = 2.59, SD = 0.70) compared to YAs [mean = 1.73, SD = 0.66, t(36) = 3.81, p = 0.005, d = 1.26].

Table 4. Daily diary retrieval use, retrieval use predictors, and reactivity responses

	Study 1						Study 2					
	young		old		age difference		young		old		age difference	
	mean	SD	mean	SD	p	d	mean	SD	mean	SD	p	d
Daily diary variable												
Retrieval use	62.77	25.56	62.75	24.70	0.998	0.00	56.26	26.03	72.33	13.49	0.008	0.77
Frequency	46.19	39.11	11.91	5.19	<0.001	1.23	16.81	15.05	29.87	30.61	0.030	0.54
Years of practice	2.51	1.55	8.47	4.53	<0.001	1.76	2.21	1.88	10.32	6.26	<0.001	1.75
Speed motivation	4.34	0.59	4.50	0.55	0.073	0.28	2.88	0.91	3.43	0.88	0.026	0.61
Accuracy motivation/risk	4.60	0.51	4.76	0.43	0.589	0.17	2.56	0.88	2.65	0.92	0.690	0.10
Memory requirement	3.43	0.82	3.85	0.67	0.113	0.27	2.94	1.16	3.65	1.02	0.019	0.65
Working memory requirement	2.78	1.06	3.00	1.21	0.554	0.10	2.26	1.11	2.75	1.24	0.118	0.42
Memory confidence	4.27	0.58	4.46	0.56	0.317	0.33	4.33	0.87	4.58	0.41	0.198	0.37
Complexity	–	–	–	–	–	–	1.62	0.63	1.56	0.55	0.685	0.10
Success rate	–	–	–	–	–	–	0.94	0.12	0.97	0.03	0.149	0.34
Reactivity responses												
Increased awareness	43.48	50.69	57.14	51.36	0.434	0.27	78.38	41.73	82.61	38.76	0.692	0.12
Increased memory use	30.04	47.05	14.29	36.31	0.280	0.38	48.64	50.67	17.39	38.76	0.009	0.71
Decreased memory use	0.00	0.00	14.29	36.31	0.065	0.55	2.70	16.44	8.70	28.81	0.370	0.26
Did not change memory use	43.48	50.69	57.14	51.36	0.434	1.20	–	–	–	–	–	–

Retrieval use = average retrieval use on the daily diary survey; frequency = participant reported times per month a specific activity is engaged in; years of practice = participant reported number of year since they first completed a specific activity; speed motivation, accuracy motivation/risk, memory requirement, working memory requirement, memory confidence, and complexity were rated by participants on a scale from 1 = not at all to 5 = very; speed motivation = motivation to perform the activity quickly; in study 1, accuracy motivation/risk = motivation to perform the activity accurately; in study 2, accuracy motivation/risk = how problematic it would have been to have failed to complete the activity successfully on the first try; memory requirement = how much the activity involved retrieving information from memory; working memory requirement = how much the activity involved temporarily holding or juggling information in memory; in study 1, memory confidence = confidence in one's ability to use memory on the activity; in study 2, memory confidence = confidence in one's ability to use the specific strategy coded as memory-based by the researchers; complexity = how complex the participant rated the activity; complexity was not measured in study 1; participants were given the option to endorse any number of the reactivity responses; increased awareness = percentage of participants endorsing the item, 'filling out the diary made me more aware of how I perform tasks'; increased memory use = percentage of participants endorsing the item, 'filling out the diary led me to rely on memory more for some tasks'; decreased memory use = percentage of participants endorsing the item, 'filling out the diary led me to rely on memory less for some tasks'; did not change memory use = percentage of participants endorsing the item, 'filling out the dairy did not change my task approach or make me more aware of my task approach'; this last option was not offered in study 2.

Analytic Strategy

We first examined overall age differences in each variable when collapsing across tasks to determine how OAs' and YAs' activities differ in experience, motivation, and confidence. These data aid the interpretation of our primary analyses which use logistic regression to model the influence of bottom-up and top-down factors on (binary) retrieval decisions.

Retrieval Use and Predictors of Retrieval Use

Collapsing across tasks, we examined average retrieval use, activity frequency (times per month), and activity duration (years). Overall retrieval use did not differ by age (see table 4 for retrieval use and predictor means). OAs' responses included activities for which they had considerably more average years of experience, but engaged in them much less frequently, compared to YAs. Thus, most activities reported in the daily diary survey were well practiced, but the level of practice was different for OAs and YAs. We comment further on the potential implications of this pattern in the Discussion section.

Confidence and Motivation

Neither average memory confidence nor motivation to be accurate differed by age. OAs reported slightly but not significantly more motivation to perform activities quickly. This latter trend is inconsistent with OAs' observed bias towards accurate responding over quick responding in laboratory studies [25,26].

Logistic Regression Analyses

To examine the influence of top-down and bottom-up factors on everyday retrieval decisions, we conducted a logistic regression analysis of retrieval use (using SAS PROC GLIMIX [32]). Our primary dependent variable was coded on a per-trial basis as participants endorsing a pure retrieval strategy (retrieval = 1) or a nonretrieval strategy (retrieval = 0; hence the use of logistic regression to model the binary retrieval decision data). We simultaneously entered into the model each of the bottom-up and top-down predictors known to influence retrieval use in laboratory settings. We also included interactions between age and each predictor to determine whether some predictors might be differentially important for OAs and YAs.

Bottom-up factors in the model included how many times per month participants engage in the activity and how many years since they first completed the activity. Both times per month and number of years exhibited positive skew and expected nonlinear (negative exponential) relationships with retrieval use [20,27]. We log transformed these predictors to linearize their relationships with retrieval use, eliminating the need to model the nonlinear relationships. However, it is important to remember that the effects of frequency of activity engagement (times per month) and years of practice are actually nonlinear (when considering their antilog counterparts).

Top-down factors in the model included memory confidence, motivation to be quick, and motivation to be accurate. We predicted that greater memory confidence and motivation to be quick would relate to greater retrieval use, but that greater motivation to be accurate would relate to less retrieval use, and that these factors would be stronger predictors for OAs compared to YAs.

Because the data are cross-classified, we included nested random effects for participants and tasks to account for the within-subjects nature of the data, as well as the nonindependence of tasks that share a domain. All variables other than age were grand mean centered. YAs served as the reference group (YA age = 0; OA age = 1). Thus, main effects indicate changes in the log odds of YAs choosing retrieval. The interaction terms indicate the increase or decrease in the regression weights for OAs relative to YAs. Table 5 shows the model results and table 6 shows the raw regression weights.

Table 5. Logistic regression models for retrieval use

	Study 1					Study 2				
	estimate	SE	d.f.	Std coef.	p	estimate	SE	d.f.	Std coef.	p
Intercept	0.61	0.56	5	0.60	0.324	0.56	0.56	8	0.99	0.372
Age	−0.14	0.44	317	−1.31	0.756	0.52	0.38	1,063	8.88	0.121
Motivation to be accurate/risk	−0.30	0.33	317	−5.35	0.356	−0.17	0.12	1,063	−8.11	0.138
Motivation to be quick	−0.02	0.31	317	−0.50	0.941	0.06	0.12	1,063	2.71	0.629
Confidence	1.22	0.29	317	23.50	<0.001	1.15	0.18	1,063	42.46	<0.001
Log years	0.03	0.22	317	0.64	0.882	0.80	0.06	1,063	11.23	0.216
Log frequency	0.84	0.17	317	25.54	<0.001	0.10	0.05	1,063	19.76	0.022
Age × motivation accuracy/risk	−0.07	0.50	317	−0.63	0.894	0.14	0.15	1,063	5.45	0.328
Age × motivation quick	0.30	0.39	317	4.42	0.442	0.35	0.16	1,063	12.79	0.028
Age × confidence	0.05	0.39	317	0.67	0.897	0.71	0.28	1,063	20.34	0.010
Age × log years	0.01	0.24	317	1.74	0.643	0.01	0.07	1,063	1.34	0.881
Age × log frequency	−0.18	0.22	317	−3.11	0.421	0.04	0.06	1,063	5.51	0.527
Person effect – intercept	0.70	0.38				1.34	0.39			
Task effect – intercept	1.33	0.97				2.19	1.19			
Residual	0.84	0.07				0.71	0.03			

Table 6. Raw regression coefficients for OA and YA's retrieval use

	Study 1		Study 2	
	YAs	OAs	YAs	OAs
Intercept	1.84	1.60	1.08	2.94
Motivation to be accurate/risk	0.74	0.69	0.84	0.97
Motivation to be quick	0.98	1.31	1.06	1.50
Confidence	3.39	3.56	3.16	6.42
Log years	1.03	1.04	2.23	2.20
Log frequency	2.32	1.93	1.11	1.15

When accounting for the other top-down and bottom-up factors, only task frequency (times per month) and memory confidence accounted for unique variance in the likelihood of selecting a retrieval strategy. Both effects were in the predicted direction, with more frequent activity engagement and higher memory confidence leading to increased likelihood of choosing retrieval. Specifically, for each unit increase in activity engagement (log time per month; 1 log time per month = 2.72 times per month, 2 log times per month = 7.39 times per month), the likelihood of retrieving increased 2.32 times in YAs and 1.93 times in OAs (table 6).[3] For each one unit increase in memory confidence (on the 5-point Likert scale), the likelihood of retrieving increased similarly for YAs (3.39 times) and OAs (3.56 times). None of the interactions with age were significant; thus, study 1 did not find evidence that OAs were more affected by top-down factors relative to YAs. To preview, significant interactions were found in study 2 with a larger sample size and refined methodology.

Accounting for bottom-up and top-down factors, there was no overall age difference in retrieval use. This is expected given that these same bottom-up and top-down factors contribute to OAs' lesser retrieval use in laboratory tasks. However, a separate model including only bottom-up

[3] The interaction between age and log times per month reached significance in initial analyses before any tasks were removed. However, the low response rates for some tasks necessitated removal, after which the interaction was no longer significant.

predictors still did not produce an age effect [$F(324) = 0.12$, $\beta = 0.146$, $p = 0.730$], or interactions between age and years [$F(324) = 0.71$, $\beta = 0.02$, $p = 0.399$], or age and frequency of activity engagement [$F(324) = 1.44$, $\beta = -0.25$, $p = 0.231$].

Survey Reactivity

Although most participants correctly recognized that the study was about memory in everyday tasks, nobody indicated that the study was about reluctance to use retrieval strategies. Roughly half of participants indicated that the survey made them more aware of how they perform tasks, and a similar proportion indicated that the survey neither increased nor decreased their use of memory-based strategies. A 2 (age; young, old) × 5 (day) repeated-measures ANOVA revealed that retrieval use did not systematically change over days; no main effects of day [$F(4, 96) = 1.04$, $p = 0.392$], age [$F(1, 24) = 0.50$, $p = 0.487$], or age × day interaction [$F(4, 96) = 0.64$, $p = 0.633$].

Discussion

Study 1 demonstrates a clear influence of both bottom-up and top-down factors on everyday retrieval use. More specifically, how often one performs a specific activity and how confident they are in their ability to use memory on the task increase the likelihood that they will use retrieval. This is important considering that top-down factors particularly contribute to OAs' retrieval reluctance in laboratory settings [20,23,24].

Study 1 asked participants to choose a representative activity when they performed a task more than once a day (e.g., drove to more than one destination that day). However, there may be differences in what OAs and YAs considered ‘representative' given that YAs often reported activities that were performed multiple times per day, whereas OAs reported activities that were often performed less than once per day. These outcomes contrast with the expectation that OAs' daily activities would be more routinized compared to YAs' [30,31]. We address this issue in study 2 by asking participants to report both the first and last instance for each task for each day (e.g., What was the first boxed meal you cooked? What was the last boxed meal you cooked?).

To increase within-subjects power and capture both weekday and weekend activities, study 2 expanded the survey to 7 days. Lastly, we were limited in our ability to enforce and assess survey compliance. Study 2 addressed this issue by using a computerized Qualtrics survey. This provided a time stamp for the start and end of each survey, allowing us to identify hasty responding. We were also able to require responses and restrict relevant fields to numerical responses, eliminating the potential for missing data within a task. Lastly, we refined or replaced the survey tasks that were unusable in study 1.

STUDY 2

Methods

Participants

We again used an unbalanced design with 36 YAs (ages 18-23) and 21 OAs (ages 61-76). An additional 12 YAs participated but failed to complete the study and were excluded from analysis. An additional 2 OAs participated but were excluded from analyses; one indicated after the study that she misunderstood the confidence ratings and the other admitted to noncompliance. YAs were undergraduates participating for course credit. OAs were recruited from the local community and paid USD 40 via gift cards. No participant reported a history of stroke or dementia. As in study 1, OAs took more medications, had more years of education, and scored higher on vocabulary [33] and lower on processing speed [34] relative to YAs (table 2).

Materials

The daily diary survey was improved in several ways. First, the survey was programmed into Qualtrics to allow better control over participant response options. All participants indicated they had regular Internet access and were comfortable completing the survey online. Second, we asked participants to report on the first and last daily activity that met the task description rather than choosing a representative example; this removed the potential for bias from participant selection of reported activities.

To better assess participants' confidence in their ability to use the specific retrieval-based strategies of interest, we had them indicate how confident they were that they *could* have used each strategy, regardless of whether they used the strategy. We then coded only the responses to the retrieval strategies as ‘retrieval confidence'. This also protected against the possibility that a participant might indicate high overall retrieval confidence based on procedural or schematic memory confidence (e.g., remembering which cookbook contains a recipe but still looking up the recipe).

Due to ceiling effects in study 1, the question regarding motivation to be accurate was reframed. Specifically, we asked participants if they successfully performed the activity on the first try and, if not, had them indicate whether they attempted the activity again using the same or a different strategy. We then asked them, if they had failed, what happened or might have happened as a result. Lastly, we had them rate how problematic the outcome would have been. This last rating was used as a proxy for how motivated they were to be accurate. Thus, motivation to be accurate was more clearly explained, and was now inversely framed in terms of risk.

We also removed unusable tasks from study 1 (making a phone call, remembering what you are shopping for, and performing mathematical calculations). We eliminated ‘entering a Web address' because of concerns that guessing could allow one to enter the Web address directly into the address bar even if the information had not been learned through practice. For example, some Web addresses are fairly intuitive and can be easily learned or entered without practice (e.g., irs.gov, walmart.com, nfl.com, weather.com). ‘Entering an e-mail address' was removed because many e-mail services have auto-complete functions that make it unnecessary to enter the full e-mail address. This function muddies the waters between algorithm and retrieval as both may start with entering the beginning of the recipient's name and end with selecting that name from a list. These tasks were replaced with new tasks (table 1). We also adjusted the mailing address task to include providing an address for any purpose (e.g., a credit card application or GPS).

Procedures

Procedures were identical to those of study 1, with the exception of not including the Personal Beliefs about Memory Inventory in study 2. For the online daily diary survey, after indicating that they performed a task at least once that day, participants responded to the follow-up questions based on the *first* time they performed the task that day. If they performed the task more than once that day, they responded to the follow-up questions again, based on the *last* time they performed the task that day. Participants completed the survey online for 7 days before returning to the lab to complete a follow-up questionnaire and debriefing.

Results

As in study 1, we examined overall age differences in predictors and retrieval use when collapsing across the various tasks on the survey before examining the influence of these variables on retrieval use. We excluded from analysis any individual surveys completed in less than 2 min, as these suggest noncompliance. This criterion eliminated seven YA surveys (each containing a single response) and no OA surveys. Three of the new study 2 tasks had to be excluded from analysis (table 1). Few OAs endorsed having walked or biked (as transportation) and always indicated doing so from memory. No OAs endorsed riding the bus, and participants almost always retrieved PINs (young = 91%, old = 100%) and passwords (young = 97%, old = 97%) from memory. Unlike study 1, we were able to retain questions regarding cooking from scratch, checking voicemail, and providing addresses, having obtained more responses and greater variance in retrieval use for these items.

After exclusion, 9 tasks remained. After eliminating the aforementioned tasks, blank surveys, and surveys completed in less than 2 min, 194 YA surveys and 151 OA surveys remained (73 and 78% of surveys were retained for YAs and OAs, respectively). This provided a total of 362 YA responses and 780 OA responses (see table 1). Thus the changes to the daily diary survey increased the amount of usable data and with it statistical power (particularly for within-subjects effects). As in study 1, OAs reported more activities per day than YAs [mean = 5.11, SD = 1.79 vs. mean = 1.88, SD = 0.68; $t(59) = 10.05$, $p < 0.001$, $d = 2.39$].

Retrieval Use and Predictors of Retrieval Use

On average, OAs reported more retrieval use compared to YAs (table 4). As in study 1, OAs' responses had more average years of experience. In contrast to study 1, OAs indicated more frequent activity engagement relative to YAs. As table 4 shows, OAs reported more frequently practiced activities in study 2 compared to study 1, but YAs reported less frequently practiced activities in study 2 compared to study 1. This may have resulted from asking for the first and last instance, rather than one ‘representative' instance. That is, OAs and YAs apparently had different ideas about what constituted a ‘representative example' in study 1.

Confidence, Motivation, and Complexity

There were no age differences in average memory confidence, risk of failure, or activity complexity.[4] In contrast to study 1, OAs' greater motivation to perform activities quickly reached significance. Again, this latter finding is inconsistent with OAs' tendency to trade speed for accuracy in laboratory studies [25,26].

Logistic Regression Analyses

We again conducted a logistic regression analysis of retrieval use including top-down and bottom-up factors (using SAS PROC GLIMIX [31]). As in study 1, frequency of activity engagement and memory confidence were significant predictors of retrieval use in the predicted directions (table 5). However, significant interactions with age suggest that motivation to be quick and memory confidence were differentially predictive of OAs' retrieval use (unlike study 1). Specifically, for each unit increase in frequency (log time per month), the likelihood of retrieving increased by 1.11 times for YAs and 1.15 times for OAs (somewhat less than in study 1; table 6). For each unit increase in memory confidence (on the 5-point Likert scale), the likelihood of retrieving increased 3.16 times for YAs (similar to study 1), but increased 6.46 times for OAs. For each unit increase in motivation to be quick (on the 5-point Likert scale), the likelihood of retrieving increased negligibly in YAs, but increased 1.50 times in OAs.

Although OAs retrieved more on average, the age difference was no longer significant after statistically controlling for bottom-up and top-down factors. However, it should be mentioned that when only controlling for bottom-up influences on retrieval use, OAs were more likely to retrieve compared to YAs [$F(1,065) = 6.14$, $\beta = 0.81$, $p = 0.013$].

Strategy Success

We analyzed responses to the question, ‘Were you successful on the first attempt' by first removing all ‘I don't know' responses (6 YA and 7 OA responses) and then coding accuracy as either being successful on the first attempt (1) or unsuccessful (0). Success rates for both age groups were near ceiling (table 4). Thus, it does not appear that OAs' increased retrieval use when motivated to be quick was at the expense of accuracy.

Survey Reactivity

Again, most participants recognized that the study examined memory in everyday tasks, but nobody indicated that the study was about reluctance to use retrieval. Most participants indicated that the survey made them more aware of how they perform tasks (table 4 shows the percentage of participants endorsing each category). YAs particularly indicated that the survey increased retrieval use. Only a small minority of participants indicated that completing the survey decreased retrieval use. As with study 1, a 2 (age: young, old) × 7 (day) repeated-measures ANOVA indicated that retrieval use did not change systematically; no main effect of day [$F(1, 268) = 0.66$, $p = 0.416$], age [$F(1, 59) = 2.12$, $p = 0.150$], or age × day interaction [$F(1, 268) = 0.01$, $p = 0.921$].

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[4] When entered into the logistic regression model, task complexity did not account for unique variance in retrieval use, nor did it substantially alter the pattern of significance or regression weights of other variables. Thus we omit this predictor to ease comparison between studies 1 and 2.

Discussion

The findings from study 2 were generally consistent with those of study 1, in that both studies demonstrate a clear influence of top-down and bottom-up factors on retrieval use in everyday life. With improved methodology, study 2 also found that top-down factors (confidence and motivation to be quick) were more important for OAs' everyday strategic choices compared to YAs, consistent with laboratory studies [20,21,24].

Overall, OAs reported activities with more frequent engagement and more years of practice than did YAs, and correspondingly reported greater average retrieval use. By contrast, YAs in study 1 reported higher frequency of activity engagement relative to OAs. This difference between studies is potentially the result of several factors. The beginning and end of OAs' days might be more routinized compared to YAs; hence the first and last activity that fit each task domain might be more frequently practiced for OAs. These more routinized activities may also be less likely to come to mind for OAs when not specifically asked to report them. Additionally, OAs in study 1 may have been reluctant to report the same activity (e.g., watching the evening news) each day, believing the redundancy to be unhelpful to the experimenter. Although studies 1 and 2 contained somewhat different tasks, those nonoverlapping tasks account for a minority of the data entered into the analyses. More importantly, study 2 used an improved measurement of memory confidence and two and four times as many data points for YAs and OAs, respectively. Thus, improved measurement and/or power may explain why study 2 obtained significant interactions not found in study 1.

GENERAL DISCUSSION

In two studies, we found strong evidence for top-down influences (confidence and motivation to be quick) on everyday retrieval decisions. Additionally, study 2 suggests that OAs weigh top-down information more heavily when deciding whether to use retrieval, mirroring laboratory findings [20,21,24]. That is, the process OAs used to make retrieval decisions in everyday tasks was similar to that used in the laboratory. By contrast, the *product* of that process (how often OAs chose retrieval) was different. OAs used retrieval as much, if not more, than YAs in everyday tasks. Although retrieval was likely more efficient in our everyday task and thus should be preferable, this is true in laboratory studies of retrieval reluctance as well [20,23,24]. The difference between our findings and laboratory studies, then, appears to result from OAs being more confident and motivated to perform quickly in everyday but not laboratory tasks.

Like other naturalistic studies [e.g., [2], [4], [6], [7]], we found age-related sparing in everyday performance. Retrieval use relies less on basic cognitive abilities than do algorithms [14,18]. OAs willingness to use retrieval in everyday life might explain both their high levels of everyday memory performance and why laboratory measures of cognitive ability do not always correlate with performance in naturalistic studies [4,6,7]. The existing literature as well as our findings underscore the need to investigate age-related difference in memory and memory-based strategies both within the controlled laboratory environment and naturalistic settings.

Both age groups used retrieval on over half of the tasks they reported, and indicated fairly high retrieval confidence - particularly OAs. The precise reason for OAs' high retrieval confidence in the current studies remains an open question. It is likely that OAs are generally more confident in their memory when information and task context is familiar and meaningful, as opposed to novel and arbitrary (as in laboratory studies). Even in laboratory studies, retrieval reluctance is reduced or eliminated when more familiar tasks, like narrative processing, are used [35]. Alternatively, retrieval reluctance may occur only in the early stages of learning (rarely captured by our survey). To test this possibility, future research should sample from inexperienced but naturalistic tasks to ensure equivalent and relatively low levels of practice for OAs and YAs.

Study 2 indicated that OAs are generally motivated to perform quickly on well-practiced everyday activities. However, unlike their YA counterparts (who may choose retrieval-based strategies irrespective of performance motivation), OAs are more likely to retrieve when motivated to be quick, and conversely less likely to retrieve when *not* motivated to be quick. Overall, OAs reported higher motivation to be quick in our study. This is surprising and contradicts laboratory research demonstrating that OAs sacrifice speed for accuracy [25,26]. Yet OAs' success rates remained high despite this, suggesting that OAs retrieval use was not at the cost of accuracy. OAs unwillingness to sacrifice speed for accuracy may be specific to laboratory settings where performance accuracy is monitored. However, OAs may still sacrifice speed for accuracy on everyday memory tasks where performance is below ceiling [e.g., [5], [8], [10]].

Study 2 produced more data points per person, per day. Yet, there were some indications that participants did not report all qualifying activities. We compared response rates in the studies by examining only tasks and days included in both studies, and examining only one instance for each task (i.e., we ignored the last time they completed a task on a given day in study 2). When restricting the data this way, study 1 participants endorsed more activities per day ($mean_{young}$ = 1.35, $mean_{old}$ = 3.00) than did study 2 participants ($mean_{young}$ = 0.19, $mean_{old}$ = 0.86). Participants may have omitted responses to avoid the lengthy series of follow-up questions, particularly on the longer study 2 survey. To combat this, future research should include follow-up questions for uncompleted tasks, as to not encourage omissions. When ambiguity occurred (e.g., is making a hot dog cooking from scratch?), participants in study 1 may have been more likely to endorse tasks in an attempt to provide more data when they completed few tasks (a liberal bias for endorsing tasks). By contrast, the greater number of items in study 2 may have led participants to adopt a conservative response bias, only endorsing tasks when their activities unambiguously fell within the survey tasks. For comparative purposes, we used a sample of OAs and YAs similar to past research examining retrieval reluctance. Although we obtained enough YA responses for modeling purposes, OAs endorsed more survey tasks. This may reflect a selection bias whereby OAs who participate in research tend to be more active. Alternatively, our survey items might have included tasks more commonly completed by OAs compared to college undergraduates. Future research should sample nonuniversity middle-aged or working YAs to see if these patterns hold. Although we believe study 2 to be largely an improvement over study 1, we feel that it is critical to fully report both studies to provide an unbiased documentation of everyday strategy choices in OAs and YAs, in order to better guide future research on the subject.

Although the daily diary method provided multiple data points for each participant (increasing within-subject power), the power to detect between-subject effects was fairly limited in our studies. Despite this, study 2 found significant main effects and interactions with age. However, it should be noted that these are likely for only the most robust interactions. For practical reasons, we only included a single measure of each predictor (i.e., confidence, motivation). Multiple measures of each predictor might yield even more accurate estimates and additional effects. Another drawback of the daily diary method is that it requires participants to retrieve from memory details about activities they completed each day. One would expect the impact of forgetting would be more pronounced in OAs. Although we cannot know how much data was lost due to forgetting, it is encouraging that OAs endorsed a high number of activities per day. Future research might use in-the-moment experience sampling to address this issue [36,37].

CONCLUSIONS AND FUTURE DIRECTIONS

Top-down and bottom-up influences play a role in OAs' and YAs' retrieval decisions in everyday life - even when sampling from activities that are generally well practiced. Furthermore, top-down influences are potentially more important for OAs. Both findings are consistent with laboratory studies of retrieval reluctance [20,23,24]. To date, these are the first studies to apply the daily diary methodology from the perspective of strategy-based skill acquisition. Future research should continue to examine the role of automaticity and retrieval use in everyday contexts using daily diary and experience sampling methods. Specifically, research should target new learning that occurs within everyday life to determine whether top-down factors such as underconfidence and motivational factors lead to OAs' retrieval reluctance for less well-practiced everyday activities.

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